Roll back malaria – an African success story in Eritrea

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Background. High morbidity and mortality from malaria in Africa prompted the Abuja Declaration by African Heads of State in 2000. The goal set in the declaration for 2010 was to reduce malaria mortality by 50%. Countries were therefore expected to ensure that 60% of people suffering from malaria had access to treatment, that 60% of those at risk received intermittent prophylaxis, and that 60% of people in high-risk groups were using insecticide-treated nets (ITNs) by 2005. In 1999 Eritrea introduced malaria policies, strategies and multi-level interventions targeting households, communities and health facilities.

Objectives. To assess Eritrea's progress towards meeting the Abuja Declaration goal, targets and key determinants.

Methods. A retrospective study was undertaken using data from the Health Management Information System (HMIS) and reports of annual reviews. Correlation and regression analysis were used to assess associations between selected variables.

Results. The incidence rate for malaria decreased from 6 000/100 000 in 1998 to 1 100/100 000 in 2003, representing > 80% decline in morbidity. The cumulative number of ITNs distributed increased from 50 000 in 1998 to 685 000 in 2003. The ITN impregnation rate increased from 15% to > 70% during the same period. Indoor residual spraying increased from 7 444 kg to 41 157 kg of insecticide in 2004 resulting in the protected population increasing from 117 017 to 244 315 respectively. The number of health workers recruited and trained rose from 936 to 4 118. There was a strong correlation between the malaria incidence rate, distribution of ITNs (R^2 = 0.76) and the total number of health workers trained (R^2 = 0.72). The association was consistent in regression analysis (β = -0.05, p = 0.03 for ITNs, and β = -0.249, p = 0.05 for trained health workers).

Conclusion. Within 5 years Eritrea met the Abuja Declaration objectives through multiple vector-control methods, case management and surveillance.

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Poverty-related diseases are currently the leading cause of morbidity and mortality in developing countries.[1] The primary culprits are tuberculosis, HIV/AIDS, acute respiratory infections, water-borne diseases and sexually transmitted diseases.[2]

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Malaria is a prevalent yet easily preventable cause of morbidity especially in vulnerable groups, mostly children and pregnant women.[3] Interventions have been developed at national, regional and global level in order to reduce further preventable carnage from malaria.

The Abuja Declaration,[4] pronounced in 2000, called on all African member states to commit themselves to drastically reduce the malaria disease burden by the year 2010. The targets of this declaration were reduction of the malaria burden by at least 60% and overall mortality by 50%, with at least 60% of persons suffering from malaria having access to prompt treatment with antimalarial drugs and at least 60% of those at risk from malaria, particularly children under 5 and pregnant women, benefiting from a suitable combination of personal and community protective measures such as insecticide-treated nets (ITNs), and at least 60% of pregnant women at risk of malaria having access to intermittent.

The roll-back malaria initiative is a global strategy to reduce the burden of malaria through provision of resources and monitoring of progress on the targets.[5] The global interventions are expected to facilitate achievement of the health-related millennium development goals especially in vulnerable groups, viz. children and pregnant women.

In Eritrea, the Ministry of Health introduced the Mendefera Declaration[6] which aimed to achieve significant reductions in malaria morbidity and mortality. The specific targets of this

declaration were to reduce morbidity and mortality by more than 80% and to increase ITN distribution to more than 70%. These targets were more stringent than those of the Abuja targets.

The Eritrea National Malaria Control Programme (NMCP), 1999 - 2003, employed a combination of control methods, namely promotion of the use of vector control through ecological management, ITNs and their re-impregnation, indoor residual spraying (IRS) using malathion or dichloro-diphenyl-trichloro-ethane (DDT), and early diagnosis and effective case management. Community involvement in vector control and case management was integral to the programme. Community health agents (CHAs) were recruited and trained in malaria diagnosis and treatment, while health workers were retrained, especially on new drug regimens. Finally, the programme monitored drug resistance and resistance to insecticide used for net re-impregnation and IRS. Annual programme reviews were conducted throughout the programme period.

The NMCP has been implementing the control activities for the past 5 years and the deadline for the target achievement has passed.

The main objective of this study was to assess the status of the control interventions and the impact they have had on malaria morbidity and mortality in Eritrea as verifiable indicators.

Methods

Study population

Eritrea is located at the horn of Africa with an estimated population of 4.1 million inhabitants. The country is divided into 6 regions, also called *zoba*. Geographically, the country is made up of three geophysical zones, the central highlands, western lowlands and eastern lowlands. The lowlands are malaria-endemic while the highlands experience seasonal cases.

Sources of data and data validation

This study was based on five main data sources.

1. The Health Management Information System (HMIS) was the principal data source for this study. The Department of Research and Human Resource Development of the Ministry of Health routinely generates this dataset. The system is managed countrywide by health workers including nurses who have undergone special training on data management, incorporating record keeping, disease encoding and compiling of health statistics. The locally generated data are relayed to the regional centre or *zoba* and subsequently forwarded in diskette format to the Department for final compilation on a monthly basis. The programme has ensured a high level of reporting compliance. The study validated the HMIS data through comparison with data from two other independent sources – data collected monthly by the NMCP itself and data generated by the integrated disease surveillance and response (IDSR) unit. Lastly, national facility and community survey data for 2001 and 2004 are in agreement with the HMIS data.

One limitation of the data is that it does not reflect the gender or the specific ages of the patients but only subdivides them into two categories, viz. children under 5 years and those above 5 years of age.

2. IDSR data from the national surveillance network regularly provides information on the national/regional disease pattern and trends. Those data have been used primarily to validate the HMIS data.

3. Anti-malarial drug resistance sentinel surveillance data collected from 12 selected sites for monitoring antimalaria drug resistance.

4. Annual reviews and annual reports for the entire study period.

5. Data collected routinely by the NMCP, results of midterm evaluation and the 2001 and 2004 surveys.

Data analysis

Data were analysed at two levels of descriptive statistics and by testing associations using Spearman's correlation coefficients and linear regressions.

Results

The malaria-endemic areas were low-lying geographical areas located in Gash Barka. Anseba, Debub, and Northern Red Sea (NRS) were in the stable malaria zone, whereas Southern Red Sea (SRS) in the eastern lowland ecological zone and Maekel in the highlands were considered to be unstable malaria areas (Fig. 1).

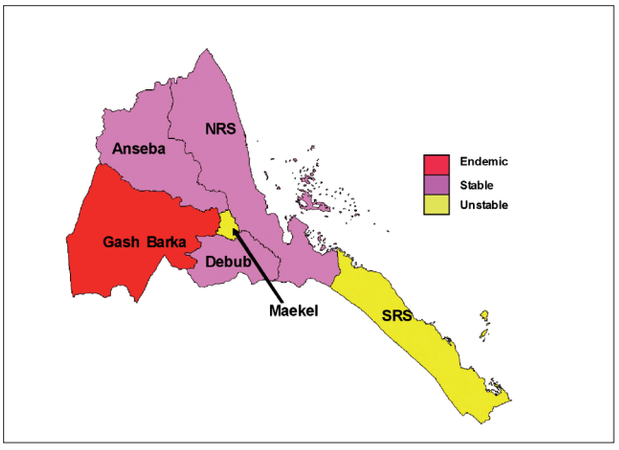

Fig. 1. Malaria endemicity in Eritrea (HMIS data).

The incidence rate decreased from 6 000/100 000 to 1 100/100 000 and from 5 500/1 00 000 to 1 050/100 000 in children under 5 years of age and persons 5 years and above respectively during the study period, reflecting > 80% reduction in morbidity (Fig. 2).

Case fatality rates (CFRs) were generally higher in children under 5 years than in older persons. This trend was maintained throughout the study period (Fig. 3).

CFRs decreased in older persons by about 30% from 1998 to 2001, then increased in 2001 before returning to the 2000 level in 2003. In children under 5 the CFR decreased after 1998 followed by an increase in 2002 and a return to 2001 levels in 2003.

There was a gradual cumulative increase in ITN distribution, on average more than 70% in the malaria areas (Fig. 4). By 2003 ITN coverage had reached high levels – 85% of households in Anseba, 70% in Gash Barka and 55.6% in Debub reported owning at least one ITN. Few households reported use of the nets year round but more than 90% used nets during the rainy seasons when mosquitoes abound. The net re-impregnation rate was reported to be quite high, viz. 93% in Anseba, 66.4% in Debub and 76.4% in Gash Barka.

There was a threefold increase in re-impregnation of the nets during the study period (Fig. 4).

From 2000 the proportion of malaria cases treated by CHAs increased by 25% and exceeded 55% of the total malaria case load (Table I).

The cumulative number of recruited and trained CHAs increased throughout the study period from 936 to 4 814. The number of health workers retrained on malaria case management increased from 443 to 1 606 during the same period. During the study period the first-line treatment for malaria was changed to chloroquine and sulfadoxine/pyrimethamine following increased drug resistance to chloroquine alone. The proportion of patients managed by CHAs increased from 20% to 80% by the end of the study period.

Indoor residual spraying (IRS) and ecological management activities intensified during the period 2000 - 2004. The community, assisted by health professionals, carried out IRS and elimination and treatment of breeding sites. The number of houses sprayed with insecticide increased from 39 838 to 84 421. The extent of IRS using DDT and malathion respectively increased from 4 045 kg and 2 399 kg in 1999 to 10 769 and 30 388 kg in 2003. The estimated number of persons protected though IRS more than doubled during the study period from 117 017 to 244 315. The number of breeding sites eliminated and treated with temephos increased from 15 988 to 21 390 and from 11 691 to 23 082 respectively during the study period.

There was a steady increase in the number of patients treated by CHAs from the year 2000. There were no records for the period before 2000.

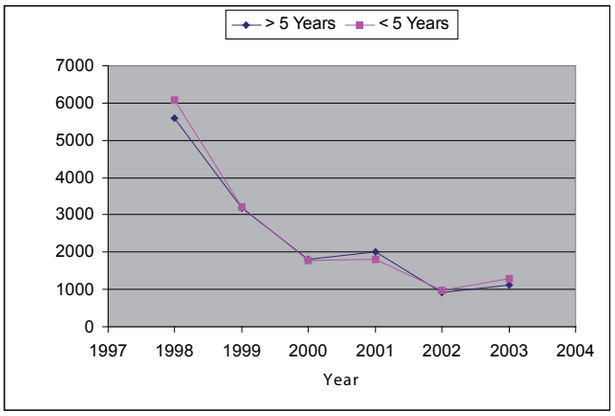

Fig. 2. Malaria incidence rates by age group (HMIS data).

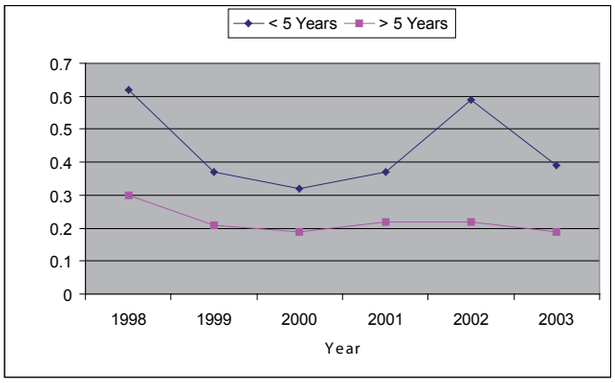

Fig. 3. Case fatality rates by age group (HMIS data).

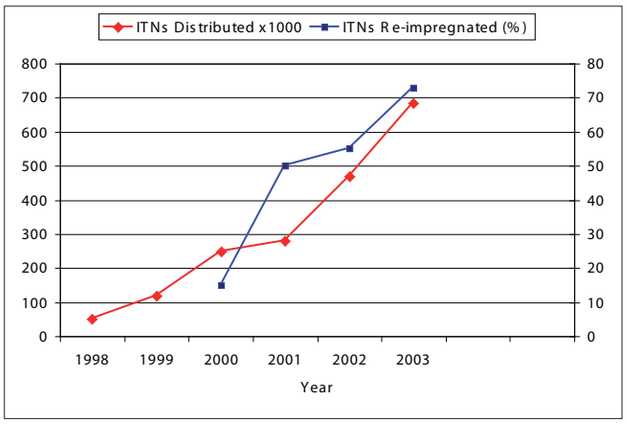

Fig. 4. ITN distribution and re-impregnation rates (data from the NMCP evaluation report 2004).

In order to assess the possible contribution of each intervention to the observed decline in morbidity and mortality from malaria, correlation coefficient and linear regression were performed using the number of ITNs distributed, ITNs re-impregnated and number of health personnel trained (Table II).

Table I. Number and proportion of patients treated by health facility and CHA (data from the 2004 NMCP report)

	Health facility		CHA		
Year	(*N*)	%	(*N*)	%	Total (*N*)
2000	118 800	49.73	120 084	50.27	238 884
2001	125 746	48.63	132 807	51.37	258 553
2002	74 861	44.43	93 611	55.57	168 472
2003	65 518	44.25	82 545	55.75	148 063

CHA = community health agent.

Table II. Correlation and regression analysis of incidence rates and interventions

Univariate linear regression		
Variable	Coefficient	*p*-value
ITNs distributed	-0.005	0.03*
Health workers trained	-0.249	0.048*
Number of ITNs retreated	-0.005	0.14
Multivariate linear regression		
Variable	Coefficient	*p*-value
ITNs distributed	-0.024	0.023*
Number of ITNs retreated	0.009	0.021*
Health workers trained	0.59	0.10

ITNs = insecticide-treated nets.

Ownership of ITNs and training of health workers significantly reduced the malaria incidence rate ($R^2 = 0.76$ and 0.72 respectively). The association was consistent in regression analysis ($\beta = -0.05$, $p = 0.03$ for ITNs, and $\beta = -0.249$, $p = 0.05$ for trained health workers). The re-impregnation rate was not strongly correlated with the malaria incidence rate ($R^2 < 0.50$). The joint effect of the three variables was strongly correlated to the decline in malaria incidence rate ($R^2 = 0.95$). The joint effect was also replicated in a model containing ITNs distributed, ITNs re-impregnated and number of health workers trained.

Discussion

This was a retrospective study based on analysis and interpretation of HMIS data and annual reports from the NMCP of Eritrea focusing on malaria morbidity and mortality and progress made towards attainment of the Abuja targets. With regard to reduction in morbidity and mortality, ITN distribution coverage, IRS use and access to treatment, Eritrea has achieved and in some instances exceeded the Abuja targets.

The key finding from this study is the drastic reduction in malaria incidence rate across all age groups. The measurable attributes of the malaria control success story in Eritrea are the guiding political declarations, free distribution of ITNs, recruitment and training of CHAs and other health workers and community participation in multiple vector reduction interventions.

Although there was a consistent decline in malaria incidence rates, CFRs, which are a proxy of case management quality, fluctuated during the same period. It is not clear why the CFR was higher in children under 5 years of age than in older persons throughout the study period. It is probable that health-seeking behaviour and malnutrition among the children could have contributed to higher CFRs in this age group, but this conjecture cannot be substantiated by available data. One can speculate that the observed gradual decline in CFRs from 1998 to 2000 in both age groups was a reflection of better malaria case management. The CFR increased from 2001 to 2002, more so in children under 5 than in older persons. There are two plausible explanations for this observation. Firstly there was disruption of health care service provision in Eritrea following military conflict during that period,[7] and secondly chloroquine resistance had increased to an extent that first-line treatment was changed from chloroquine alone to chloroquine plus sulfadoxine/pyrimethamine.[8]

Effective case management, ITN use and IRS had the greatest impact in reducing malaria incidence and case fatality in Eritrea. Studies from Kenya[9] and South Africa[10] have demonstrated the efficacy of consistent use of effectively treated ITNs. Although contentious, use of DDT has been shown to be consistently effective in the control of malaria vectors. In the study, the free distribution of ITNs resulted in almost geometric rise in ITN coverage in the community, with a corresponding fall in malaria morbidity and a strong correlation between these two variables. This provides indirect evidence of the impact of ITN use on malaria transmission. The effect of IRS was not statistically significant, probably as a result of the relatively low coverage rates realised during the study period.

The increasing contribution of CHAs in the case management of malaria could have contributed to the improvement in access to effective antimalarial drugs and early treatment. The effect of this was reduced case fatality and caseload at the health facilities. This has been shown to be true in other settings.[11] The quality of case management by CHAs remains unclear as the country has not introduced the use of rapid test kits in the community.[12]

In this study there were inadequate data to evaluate the contribution of each of the different ecological interventions on malaria incidence in the country. Such a study would involve direct determination of density of the vectors in the high-transmission *zobas*. Previous studies[13] in the country have shown seasonal variability and biting habits of the predominant vector, *Anopheles arabiensis*.[13]

The major limitations of this study are inherent in the nature of the HMIS. The information is biased towards people who seek health care at health facilities, yet a substantial proportion of patients still use traditional or alternative medicine options.

The timeliness and completeness of the information is variable. There is no community-based information component in the HMIS, although the majority of malaria cases are now managed in the community. In spite of these limitations, HMIS data completed from annual NMCP reviews and other periodic reviews provides quality information that can be used to guide policy development in resource-poor countries.

In summary, therefore, the Abuja Declaration targets were met on schedule because the government had set even higher targets for itself, a reflection of very strong political commitment. Extensive community and personal prevention measures were introduced, starting with the donation of ITNs. These measures initially targeted pregnant women and children and were sustained through community awareness. Prompt case management by competent staff using revised treatment guidelines reduced mortality. Both morbidity and mortality have declined to a point where malaria is no longer a major infectious disease in this small African country.

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